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CONSTRUCTION FEATURES OF DRILLING TOOLS AND MACHINES IN MINING

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Abstract

Non-destructive methods for examination and control of parts and assemblies of structures allow determining the probable causes of boils and fractures after unacceptable loads. Some of the evaluations were made in the Laboratory of "Destructive Control" at the Institute of Metal Science, Equipment and Technologies with Hydro- and Aerodynamics Centre, "Acad. A. Balevski".

Key words: non-destructive testing, visual examination methods, radiographic test method, capillary method

Introduction. State authorities in the country, such as the regional departments of the Ministry of Internal Affairs and the investigative departments of the relevant departments, provide us with material evidence (materials, assemblies and parts) for examination, which led to production accidents or accidents after improper use of the equipment.

Based on this, data were tracked for a vertical drilling hammer type Hammer and a piston from a drilling machine brand FlexiROC D50 (Fig. 1).

The tests were conducted in the Laboratory for Non-Destructive Testing at IMSETHAC-BAS.

Test methods. Visual control tests are done according to standards [1, 2]. Rent-rate and penetrating liquid testing were performed according to standards [3–6].

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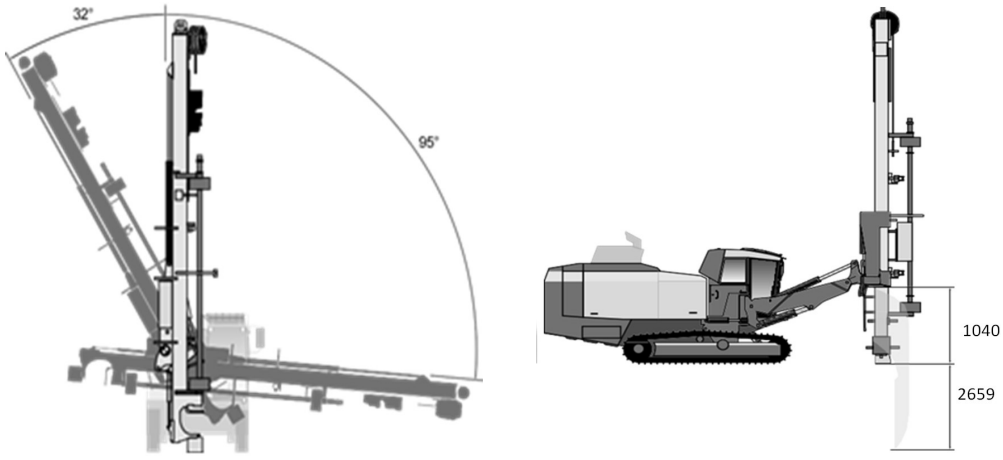


a. Feed swing angles b. Vertical reach

Fig. 1. Product FlexiROC D50

Non-destructive control with radiation methods and with Roentgen defectoscope of type 200/5 model MXR-200 were done. Technical parameters: spot focus 2.45 × 2.80 mm; anode current 5 mA; tension 180 kV at measured equivalent dose 0.210 mSv with tapping ±0.8%. Work conditions and reading of the Roentgenograms are in conformity with Standards BDS EN ISO [1, 7].

Calibration and certification are in accordance with Industrial X-ray system MXR 200 (No. 201017).

Certificate of calibration No. 553-Ro/22.05.2023; Negatiscope KL-1500 (No. 151) Certificate of calibration No. 462-HC/21.06.2018; Radiographic technology B; film system C4, film D7.

Capillary control was performed according to standards [3–6].

Equipment used: Caliper No. 187, Certificate of calibration No. 187-ID/ 03.12.21;

Lux meter MS6610: No. MBFG077505, Certificate of calibration No. 35-OI/11.03.2024;

Set penetrants: DIFFU-TERM 890, 871, 860, Certificate of 07.11.2022.

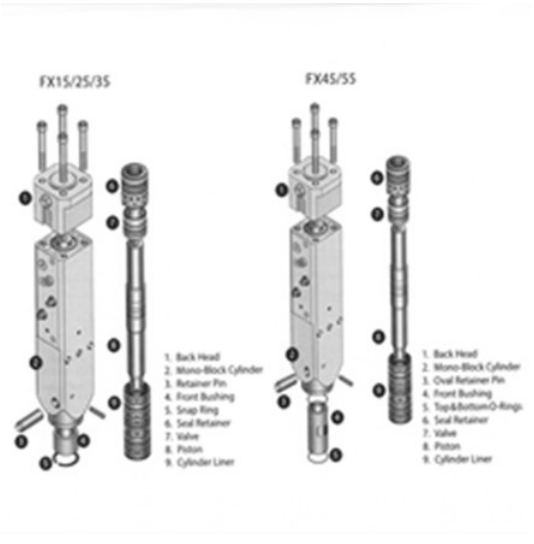
Product. *Metal materials and forging.* A test to clarify the reasons for breaking a hydraulic hammer workpiece plunger with No FURUKAWA.

Details of a geological exploration company – piston Fig. 2a, b position No. 8 in the structural documentation – from broken hydraulic hammer FURUKAWA.

The specimen is of steel type 40Ch2N2MA. DIN analogue 1.6565 40NiCrMo 6; Analogue: Japanese brand JAPAN JIS No. G 4103 steel grade SNCM8 type.

The rolled steel of the above-mentioned material is 160 mm and within the limit of 100÷400 mm is with subsequent heat treatment of the forgings – tempering 850 °C in oil and annealing at 610 °C, which allows a workpiece made with

a. Broken piston



b. Documentation of the piston position No. 8

Fig. 2

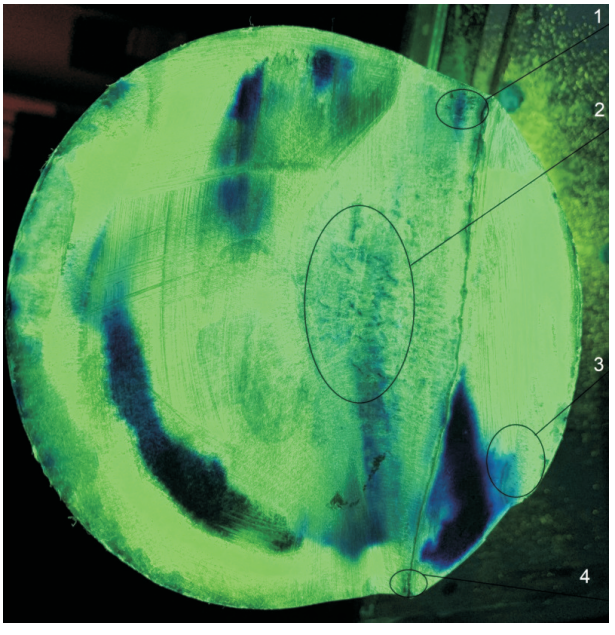


Fig. 3. Analysis with penetrating fluids of workpiece from Fig. 2a
1 – Cluster of pores in the fracture region and an incipient crack about 35 mm long;
2 – Cracks min 15 pieces with lengths between 1.5 and 12 mm;
3 – Single pores between 0.5 and 2 mm;
4 – Pores and a crack measuring about 9 mm.

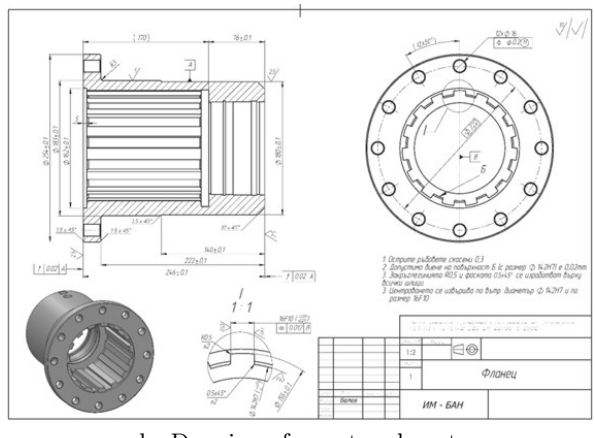
additional machining to be loaded to an impact of 5120 J energy according to the BDS EN ISO 6892-1:2020 Metallic materials – Tensile testing – Part 1: Method of test at room temperature (ISO 6892-1:2019).

After the radiographic control according to the current standards BDS EN ISO [1] and [7] Fig. 3 shows the found inadmissible gaps A $>$ 10%.

Capillary NDT. It was found in compliance with standards [3–5, 7]. Pores with a length of more than 0.5 mm and cracks with a length of 2.2 mm, 3 mm and a main crack with a length of 4$\div$5 mm were found.

The drilling head is mounted using a Flange on which internal splines are made (Fig. 4b). The use of a spline joint is necessary for the following reasons. These joints provide axial movement of the rotating part relative to the hub. They also allow for good centering, uniformity of movement of the hub relative to the shaft and provide very good strength of the joint under variable and dynamic loads. The selected spline joint is a heavy series with a rectangular profile of the teeth located parallel to the axis of the joint. The number of teeth is 15. Centering is performed along the inner diameter ∅142H7. This allows for grinding the inner side of the hole and obtaining greater accuracy.

a. Broken teeth on a working flange



b. Drawing of a restored part

Fig. 4

Conclusion. The detail of the FURUKAWA FXJ 275 hydraulic hammer was broken due to the large number of cracks inside the forging, as well as pores and cracks at two diametrically opposite ends that led to a highway crack.

Established defect A $>$ 10%;

Non-linear indication ∅ $>$ 0.5 mm – CP3, LP7;

Linear indication L – 2 $\div$ 12 mm – CP8, AP8.

In the second detail – part of an elliptical element with screw M6 clearly distinguishes two zones: brittle and plastic. The area occupied as a result of the brittle destruction of the element is twice as large as the plastic zone. The regis-

tered cracks inside the forging, as well as pores (in blue) at the two diametrically opposite ends, clearly show the dividing line of destruction. The demolition area clearly indicates that the load is above the allowable. Unfortunately, the element was part of the equipment for climbers and shearing the stem of the bolt could cause compromising of climber equipment.

The manufacturer provides instructions on the permissible defects after multicycle loading.

Figure 4a shows the part after use in normal operation, without overload in operation. The defects – broken teeth on the flange – are visible. It was necessary to manufacture the part (Fig. 4b) with the material selected after analysis and the necessary heat treatment.

REFERENCES

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[2] Visual testing. General principles Released: 2016-02-29; BS EN 13927:2003 Non-destructive testing. Visual testing. Equipment, 2003.

[3] ISO 3452-1:2021 Non-destructive testing – Penetrant testing – Part 1: General principles; ISO3452-2:2021(en) Non-destructive testing – Penetrant testing – Part 2: Testing of penetrant materials.

[4] BS EN 10228-2:2016 Non-destructive testing of steel forgings. Penetrant testing.

[5] ISO 23277:2015 Non-destructive testing of welds – Penetrant testing – Acceptance levels.

[6] ISO 10675-1:2021 Non-destructive testing of welds – Acceptance levels for radiographic testing – Part 1: Steel, nickel, titanium and their alloys; EN ISO 17637:2016 Non-destructive testing of welds – Visual testing of fusion-welded joints; EN 1371-2:2015 Liquid penetrant testing – Part 2: Investment castings.

[7] BS ISO 5579:2013 Non-destructive testing – Radiographic testing of metallic materials using film and X- or gamma rays – Basic rules.

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